TOWN BROOK
QUINCY, MASSACHUSETTS

HYDROLOGIC ANALYSIS OF FLOODS

HYDROLOGIC ENGINEERING SECTION
WATER CONTROL BRANCH
ENGINEERING DIVISION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

DECEMBER 1979

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TOWN BROOK
HYDROLOGIC ANALYSIS OF FLOODS

1. PURPOSE

This study report presents an update, review, and analysis of the flood hydrology for Town Brook in Quincy, Massachusetts. Included in the study was the development of an HEC-1 computer model using information from previous studies plus seven years of stream flow records. The purpose of the study was to reaccess the development of floods on the brook, the frequency and magnitude of flood events, and the effects of pending and proposed channel modifications.

2. PROCEDURE

The study procedure was as follows:

a. The watershed was divided into subareas. Stage-storage, stage-discharge and unit hydrographs were developed and inputted into the HEC-1 computer model.

b. The model was calibrated by analyzing and reproducing selected rainfall-runoff events recorded during the short term 7-year gage record.

c. Once the model was calibrated, a series of flood events were modeled applying both historic and synthetic storm rainfall. This information was then used to derive flood magnitude and frequency information.

d. The hydrologic effects of pending and proposed modifications to the channel were then analyzed by making appropriate changes in the stage-discharge relations in the model and rerunning a selected flood series.

3. WATERSHED DESCRIPTION

Town Brook has a total watershed area, above tidewater, of approximately 4.5 square miles. The brook originates at Old Quincy Reservoir in Braintree, a reservoir built in the 1880's as a water supply for Quincy but now used only as a source of industrial supply. This reservoir has about 1.5 square miles of relatively flat quite highly developed watershed. Though it was noted by the original designers of the reservoir that the watershed was 1,000 acres of poor land not suitable for cultivation and would not ever be developed, the area is now criss-crossed by expressways, contains a shopping center, plus extensive other commercial and residential development. Presently, efforts are made to maintain the reservoir six to eight feet below spillway crest to provide some runoff storage for reducing downstream flooding.

Downstream of the reservoir, the stream flows easterly through a residential section of Braintree, beneath the Route 3 expressway and into the Centre Street flood plain area of Quincy. The intervening area between the reservoir and Centre Street is 1.4 square miles made up of rolling moderately developed area comprised of single family residences, industries, highways and old stone quarries.

From the Centre Street flood plain area, the brook continues to flow easterly at an extremely flat gradient along Brook Street to School Street. The brook is mostly underground in this reach either in concrete conduit or capped granite walled rectangular channel. This reach, with an intervening drainage area of about 0.8 square miles, has a long history of flooding and development in the flood plain in the past was mostly the stone quarry related industry and older residences of Quincy. However, the advent of expressways and the extension of a rapid transit line through the area has brought accelerated development pressures for large apartment complexes, schools, and added commercial development.

From just downstream of School Street, the stream is conveyed underground through the center of the city of Quincy, one of the oldest cities in the United States, the home of the Hancocks and Adamses, and the birthplace of two U.S. Presidents.

The intervening drainage area of the stream in central Quincy is about 0.7 square miles of highly developed urban area and the brook enters tidewater near Washington Street where the total drainage area is a little over 4.5 square miles.

A watershed map of Town Brook is shown on plate 1. Plans and profiles of the brook from the vicinity of Centre Street to Washington Street are shown on plates 9 and 10. For purposes of hydrologic analysis, the watershed was divided into the following subareas:

Subarea	Drainage Area (sq. mi.)	Accumulative
Old Quincy Reservoir	1.56	1.56
Local to Centre St. Storage	1.42	2.98
Local to Brook Rd. Storage	0.79	3.77
Local to Upper Reach of Quincy Conduit	0.27	4.04
Local to Bigelow Gage	0.42	4.46

Potential modifications in the brook channel consist of a planned auxiliary conduit, by others, extending from near Centre Street to downstream of School Street, and a proposed Corps of Engineers tunnel extending from the auxiliary conduit outlet, beneath Quincy to Town River bay. The approximate alignment of these improvements are shown on plates 1, 9 and 10.

4. DISCHARGE RECORDS

There are no long-term discharge records for Town Brook. However, as part of ongoing flood studies, the U.S. Geological Survey, at the request of the Corps of Engineers, installed a stage recorder on Town Brook in September 1972. This station is located near Bigelow Street (drainage area 4.46 sq. mi.) a short distance upstream from where the stream enters tidewater at Washington Street. The station has been in continuous operation since September 1972 thus providing seven years of stream records. These records, though of relatively short duration, proved useful in the development and calibration of the HEC-1 computer model.

5. STAGE-DISCHARGE RATINGS

Stage discharge relationships were developed for Old Quincy Reservoir and at selected index stations along Town Brook. The discharge rating at Old Quincy Reservoir was developed for the 25-foot long overflow spillway at elevation 80.9 NGVD and for an overbank flow area with an assumed length of 50 feet and at an approximate elevation of 83 feet msl. Capacities were computed using the conventional weir formula with "C" values of 3.2 and 2.6 for the spillway and overflow area, respectively.

Stage-discharge rating curves were developed for selected index stations along the brook using available cross-sectional information and stream gradients. Capacities were computed by Manning's equation using "N" values ranging from 0.015 for smooth concrete to 0.030 for rock channel and overland flow. Key index stations for the study were:

Index #2	-	Bigelow Street Gage Rating
Index #2A	-	Quincy Conduit Rating
Index #3	-	Brook Road Conduit Rating
Index #4	-	Centre Street Storage Outflow Conduit Rating

Stage-discharge relations were developed assuming normal flow through the immediate reaches and then were later adjusted as necessary to reflect the effect, under certain flood conditions, of significant downstream backwater. Both Brook Road and Centre Street stages were in many cases a function of downstream backwater.

The adopted normal flow rating curves, both for existing and modified channel conditions, are shown on plate 2.

The stage-discharge curve developed at Bigelow Street deviates somewhat from that adopted by the USGS. The USGS rating was based on measured flows up to 300 cfs and the upper range of the curve defined by log-log extension. The curve computed in the current study agreed with the USGS curve in the lower range but indicated less capacity in the upper range due to the restrictive downstream conduit. Both the USGS rating curve and that computed and adopted in the current study are shown on plate 2. Peak annual stages at Bigelow Street and the corresponding peak discharges using both ratings are comparatively listed in table I.

The rating curve at Centre Street, for improved conditions, was based on an assumed 8 x 10 foot conduit with an invert at elevation 18 feet msl and an energy gradient of 0.001 ft/ft. Adjustments were then made in this rating as necessary to reflect downstream backwater effects. In developing the unrestricted improved channel rating at the proposed tunnel entrance below School Street, the rating of the improved channels was assumed equal to twin 8 x 10 foot conduits, or twice that at Centre Street, above the invert of the existing conduit at about elevation 16 feet NGVD. With the various tunnel plans, it was further assumed that overflow to the tunnel would not occur until the water level approached 20 feet NGVD, but once overflow commenced, it was assumed that the inlet would be designed to provide ample capacity to the tunnel with little further increase in stage, allowing either the tunnel or the upstream channel to become the hydraulic control rather than the inlet structure. It was further assumed, that if a diversion tunnel was built, residual flood flows allowed to enter the existing Quincy conduit would be restricted to about 100 cfs, thereby increasing flood control benefits downstream. The actual inlet design and allowable downstream flow would be refined in any final design and would likely vary somewhat from the assumed conditions but it was believed that the above assumptions provided information adequate for the hydrological assessment of the flood control potential of the various plans of improvement.

Capacities for various sized deep rock tunnels beneath Quincy were based on a length of 3,800 feet, a Manning's "N" of 0.015, an entrance "K" of 0.5, an exit "K" of 1.0 and a design tailwater level of 7 feet NGVD.

6. STORAGE CAPACITIES

Three principal flood storage areas in the watershed were analyzed using the "modified puls" method of storage routing. The three storage areas were: Old Quincy Reservoir, Centre Street and Brook Road. Though other areas along Town Brook experience flooding, the

TABLE I

TOWN BROOK GAGE
PEAK ANNUAL STAGES AND COMPARATIVE FLOWS

Date	Peak Stage (ft)	"Q" USGS Rating (cfs)	"Q" Corps Rating (cfs)
August 1973	6.83	378	335
August 1974	6.79	372	330
May 1975	7.44	481	385
August 1976	7.08	442	365
August 1977	5.34	268	268
January 1978	5.62	289	285
January 1979	6.93	430	360

Datum of Gage = Approximately 5 feet NGVD volume of flood plain storage in these areas is not sufficiently large to significantly affect flood hydrograph peaks. The storage capacities for the three principal storage areas were determined by planimetering topographic maps of the areas and from information developed by Metcalf & Eddy, Inc. Engineers in earlier ongoing studies of the brook. Storage capacity curves for the three areas are shown on plate 3.

All routings were made with Old Quincy Reservoir initially at elevation 73.4 feet NGVD, 7.5 feet below spillway crest. This is the average or normal level of the reservoir under present operation, though it often fills above this level during freshets. Two comparative flood routings were also made with the reservoir assumed initially full. This data is summarized in table V.

7. UNIT HYDROGRAPHS

Flood hydrographs for the different subareas were computed by applying storm rainfall to adopted unit hydrographs. Unit hydrographs were developed for each subarea using varying "Snyder's coefficients" based on watershed characteristics. The coefficients were then refined in the process of calibrating the HEC-1 computer model. The watershed characteristics and finally adopted coefficients are listed in table II.

8. STORM RAINFALLS

The greatest flood producing storm rainfall of record in the Quincy area occurred in August 1955 as a result of rainfall associated with Hurricane "Diane". This storm produced about 5.3 inches of rainfall in a six-hour period and, though the upper watershed was much less developed than today, the resulting flood in Quincy was believed to be the greatest in that city's history.

The second greatest flood producing rainfall of record, and one of most recent vintage, occurred in March 1968. This storm produced a maximum six-hour rainfall of only 2.5 inches but the 18-hour total was about 5.7 inches. This storm occurred at a time of very high antecedent conditions, greatly aggravating the resulting flooding which in many areas along Town Brook was nearly equal to that of 1955.

Two other notable storm rainfall events of record in Quincy, which were associated with hurricanes or coastal storms, occurred in September 1954 and September 1961. Fortunately, these storms occurred at times of lower antecedent conditions than those of the 1955 and 1968 flood events.

TABLE II

UNIT HYDROGRAPH PERTINENT DATA

Subarea	Area (sq.mi.)	"L" (ft)	Slope (ft/ft)	"Synder's" Tp	"Synder's" Cp	"Clark's" Tc	"Clark's" R
Old Quincy Reservoir	1.56	10,000	.017	2.5	0.50	10.6	13.6
Local to Centre Street Storage	1.42	6,000	.020	2.0	0.55	8.8	9.3
Local to Brook Road Storage	0.79	4,000	.015	1.5	0.55	6.8	6.8
Local to Upper Reach of Quincy Conduit	0.27	2,000	.030	1.0	0.60	4.7	3.7
Local to Bigelow Gage	0.42	2,000	.010	1.0	0.60	4.7	3.7

Maximum short duration storm rainfalls, experienced during the period of stream records since 1972, occurred in August 1973 and 1974, May 1975 and January 1979. The maximum one-hour and six-hour rainfalls for these recent storms as well as the historic events and synthetic 100-year and 10-year rainfalls, as determined from U.S. Weather Bureau T.P. #40, are listed in table III. Rainfall-time distribution for the August 1955, March 1968 and January 1979 storms are graphically illustrated on plates 4, 6 and 7.

9. ANALYSIS OF FLOODS

A series of storm rainfall events, that occurred during the period of stream record since 1972, were analyzed in the development and calibration of the HEC-1 computer model. In calibrating the model, it was found necessary to increase initial estimates of Snyder's "Tp" to establish reasonable agreement in timing between rainfall and runoff. These increased "Tp's" resulted in somewhat lower unit graph peaks than were initially estimated. The component development of the January 1979 storm runoff, using the finally calibrated model is graphically illustrated on plate 4. Comparisons of model computed and observed data for the storms of January 1979, August 1973 and May 1975 are graphically illustrated on plate 5. The deviation between computed and measured flow on the recession side of the August 1973 and May 1975 hydrographs is attributed to flows entering flood plain areas, being partially absorbed, and not readily returned to the stream as was the case in January 1979, when flood plain soils were frozen or near saturated from earlier rainfall and/or snowmelt.

Once the model was calibrated, through analysis of the recent storm events, it was used to develop and analyze both historic and synthetic 100 and 10-year flood runoff. The component development of the recurring August 1955 and March 1968 floods are graphically illustrated on plates 6 and 7. Comparative data for a series of floods is listed in table IV.

10. EFFECTS OF IMPROVEMENTS

Lastly, planned and proposed improvements of Town Brook were hydrologically analyzed, by adjusting stage-discharge relations in the model to reflect such improvements. The improvements considered consisted of an auxiliary channel, by others, between index 4 and 2A, and a proposed tunnel from index 2A beneath downtown Quincy to tidewater in Town River.

Analyses consisted of adjusting the stage-discharge relations in the model to reflect the hydraulic changes and then rerunning a selected flood series. Studies were made for conditions with

TABLE III

STORM RAINFALLS

Storm	1 Hour Maximum (inches)	6 Hour Maximum (inches)
August 11, 1973	0.74	1.3
August 29, 1974	1.53	1.9
May 13, 1975	1.24	1.6
January 21, 1979	0.36	1.7
September 11, 1954	0.95	4.2
August 19, 1955	1.74	5.3
September 21, 1961	0.88	2.3
March 18, 1968	0.50	2.5 (18 hr. = 5.7")
100 year	2.6	4.8
10 year	1.8	3.4

TABLE IV

COMPARATIVE FLOOD DATA

	Quincy Reservoir			Centre Street (Index #4)			Brook Road (Index #3)	M.T.A. Line (Index #2A)			Bigelow Street (Index #2)	
	Inflow (cfs)	Outflow (cfs)	Stage (msl)	Inflow	Outflow	Stage	Stage	Inflow	Outflow	Stage	Outflow	Stage
MARCH 1968 FLOOD ANALYSIS — RAINFALL EXCESS = 4.6 INCHES IN 18 HOURS												
Existing Conditions	356	150	82.5	355	180	33	27.6	430	330	24	425	13.2
With Upstream Improvements	356	150	82.5	355	-	29	28.9	635	470	28.7	530	15.1
Upstream Imp. + 12 Ft. Tunnel	356	150	82.5	355	355	24	22.5	635	630	21.5	220	9.7
AUGUST 1955 FLOOD ANALYSIS — RAINFALL EXCESS = 5.0 INCHES IN 7 HOURS												
Existing Conditions	745	200	83	835	357	33.8	29.5	900	450	28.4	720	16.2
With Upstream Improvements	745	200	83	835	-	31.3	31.0	1300	760	30.8	870	16.8
Upstream Imp. + 12 Ft. Tunnel	745	200	83	835	600	30.1	26.8	1300	1235	24.7	450	14.2
AUGUST 1973 FLOOD ANALYSIS — RAINFALL EXCESS = 1.1 INCHES IN 3.25 HOURS												
Existing Conditions	190	0	76.3	225	130	29.0	22.0	350	250	21.0	335	11.0
With Upstream Improvements	190	0	76.3	225	-	22.4	22.2	455	300	22.0	364	12.0
Upstream Imp. + 12 Ft. Tunnel	190	0	76.3	225	225	22.2	20.9	455	415	20.0	220	9.7
10-YEAR FREQUENCY SYNTHETIC FLOOD — RAINFALL EXCESS = 2.2 INCHES IN 2 HOURS												
Existing Conditions	410	0	79.0	500	150	31.2	27.8	625	360	25.5	550	15.2
With Upstream Improvements	410	0	79.0	500	-	28.9	28.4	1009	420	28.1	566	15.4
Upstream Imp. + 12 Ft. Tunnel	410	0	79.0	500	500	25.6	23.9	1009	870	22.8	363	12.0
100-YEAR FREQUENCY SYNTHETIC FLOOD — RAINFALL EXCESS = 3.3 INCHES IN 2.5 HOURS												
Existing Conditions	620	30	81.0	750	170	32.6	29.8	880	400	28.0	720	16.2
With Upstream Improvements	620	30	81.0	750	-	30.5	30.2	1290	630	30.0	740	16.3
Upstream Imp. + 12 Ft. Tunnel	620	30	81.0	750	570	29.0	26.2	1290	1130	24.2	500	14.8

upstream improvements alone, i.e. auxiliary conduit, and with upstream improvements plus installed Quincy tunnel.

Computed discharges and stages for a series of floods are listed in table IV for three conditions: (1) existing conditions, (2) upstream improvements by others between index 2A and 4 with no tunnel, and (3) upstream improvements plus a 12-foot Quincy tunnel.

The hydrologic effect of the channel improvements, in general, is to reduce flood plain storage and increase peak flood discharges. It is noted, however, that the effect of the planned upstream improvements, alone without the tunnel, is to release more flows from the Centre Street storage into the Brook Road storage. This would reduce flooding in the Centre Street area but could increase downstream flooding unless increased discharge capacity is provided downstream. This is demonstrated by the comparative March 1968 flood profiles shown on plates 9 and 10.

Table V is also provided to demonstrate the effect if Quincy Reservoir were assumed initially filled to spillway crest. The demonstration floods, the March 1968 and 10-year synthetic, are considered representative of moderate range floods, one being of a short duration high intensity type and the other a longer duration higher volume floods.

11. FLOOD FREQUENCIES

Natural discharge frequency curves for Town Brook were established by assigning "Weibul" plotting positions to the seven annual peak flows of continuous record and associated plotting positions to the computed historical and synthetic flood flows. A natural discharge frequency curve was then fitted to all the plotted data as shown on plate 8 for index stations 2 and 2A. Having established natural discharge frequencies, natural flood stage frequencies were developed using the established stage-discharge relationships.

Modified discharge frequency curves, for varying plans of degrees of channel improvement, were then developed by modeling a selected series of index floods under modified conditions. The selected flood series was the August 1955, 100-year synthetic, March 1968, 10-year synthetic and August 1973 storms. Plotted data for these floods, for the plan including both upstream improvements and tunnel, are illustrated on plate 8 for index stations 2 and 2A.

Natural and modified stage frequency curves at all four index stations are shown on plate 8 for the following conditions: (a) natural, (b) upstream improvements with no tunnel, (c) upstream improvements and 8-foot diameter tunnel, and (d) upstream improvements and 12-foot diameter tunnel. These stage frequency curves were developed for use by others in establishing the economic feasibility of the planned and proposed system of improvements for flood control on Town Brook.

TABLE V

EFFECTS OF INITIAL STORAGE AT OLD QUINCY RESERVOIR

MARCH 1968 FLOOD ANALYSIS

	Quincy Reservoir			Centre Street (Index #4)			Brook Road (Index #3)	M.T.A. Line (Index #2A)			Bigelow Street (Index #1)	
	Inflow (cfs)	Outflow (cfs)	Stage (msl)	Inflow	Outflow	Stage	Stage	Inflow	Outflow	Stage	Outflow	Stage
Existing Conditions	356	150	82.5	355	180	33	27.6	430	330	24	425	13.2
(With Reservoir Initially Full)	(356)	(320)	(83.3)	(625)	(520)	(34.3)	(30.5)	(630)	(430)	(28)	(510)	(14.8)
With Upstream Improvements	356	150	82.5	355	-	29	28.9	635	470	28.7	530	15.1
(With Reservoir Initially Full)	(356)	(320)	(83.3)	(625)		(30.3)	(30.1)	(825)	(675)	(30)	(730)	(16.2)
Upstream Imp. + 12 Ft. Tunnel	356	150	82.5	355	355	24	22.5	635	630	21.5	220	9.7
(With Reservoir Initially Full)	(356)	(320)	(83.3)	(625)	(570)	(28)	(24.7)	(825)	(810)	(22.5)	(220)	(9.7)

10-YEAR FREQUENCY SYNTHETIC FLOOD

	Quincy Reservoir			Centre Street (Index #4)			Brook Road (Index #3)	M.T.A. Line (Index #2A)			Bigelow Street (Index #1)	
	Inflow (cfs)	Outflow (cfs)	Stage (msl)	Inflow	Outflow	Stage	Stage	Inflow	Outflow	Stage	Outflow	Stage
Existing Conditions	410	0	79.0	500	150	31.2	27.8	625	360	25.5	550	15.2
(With Reservoir Initially Full)	(410)	(210)	(82.8)	(560)	(170)	(32.8)	(28.3)	(625)	(360)	(25.5)	(555)	(15.3)
With Upstream Improvements	410	0	79.0	500	-	28.9	28.4	1009	420	28.1	566	15.4
(With Reservoir Initially Full)	(410)	(210)	(82.8)	(560)	-	(29.2)	(28.8)	(1030)	(487)	(28.6)	(568)	(15.4)
Upstream Imp. + 12 Ft. Tunnel	410	0	79.0	500	500	25.6	23.9	1009	870	22.8	363	12.0
(With Reservoir Initially Full)	(410)	(210)	(82.8)	(560)	(560)	(26)	(24.2)	(1030)	(900)	(23.0)	(363)	(12.0)

NOTE: Base runs start with Old Quincy Reservoir initially at El. 73.4' NGVD

Comparative "Full" runs start with reservoir at spillway crest: El. 80.9' NGVD

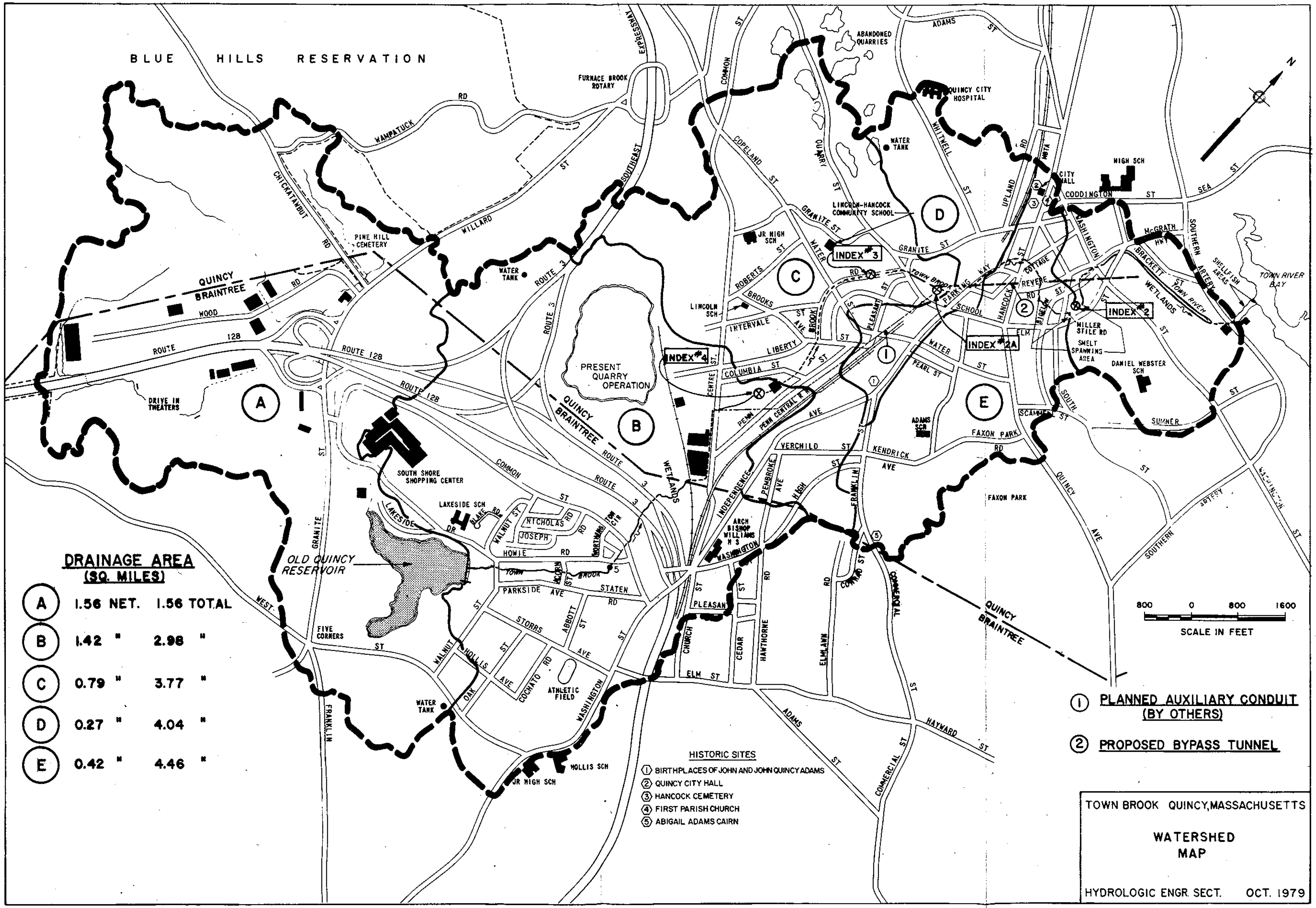
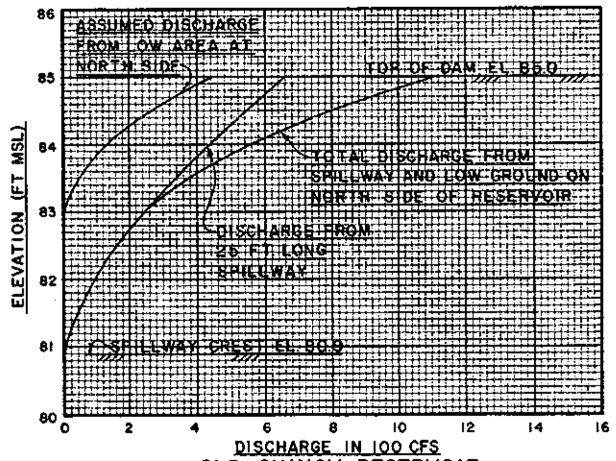
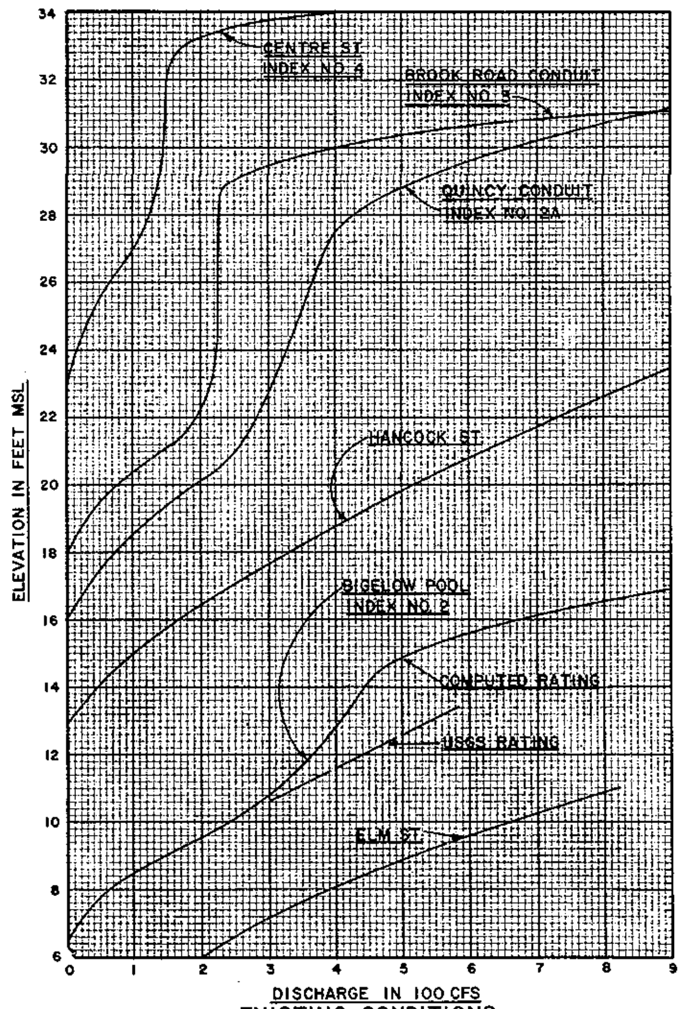

BLUE HILLS RESERVATION
FURNACE BROOK ROTARY
ABANDONED QUARRIES
QUINCY CITY HOSPITAL
WATER TANK
HIGH SCH
CITY HALL
LINCOLN-HANCOCK COMMUNITY SCHOOL
JR HIGH SCH
INDEX #3
INDEX #2
INDEX #2A
INDEX #4
PINE HILL CEMETERY
QUINCY
BRAINTREE
PRESENT QUARRY OPERATION
DRIVE IN THEATERS
SOUTH SHORE SHOPPING CENTER
LAKESIDE SCH
OLD QUINCY RESERVOIR
FIVE CORNERS
ATHLETIC FIELD
HOLLIS SCH
ARCH BISHOP WILLIAMS H S
MILLER STILE RD
SMELT SPAWNING AREA
DANIEL WEBSTER SCH
SHELLFISH AREAS
TOWN RIVER BAY
FAXON PARK
ADAMS SCH
WETLANDS
TOWN BROOK
N
DRAINAGE AREA (SQ. MILES)
A 1.56 NET. 1.56 TOTAL
B 1.42 " 2.98 "
C 0.79 " 3.77 "
D 0.27 " 4.04 "
E 0.42 " 4.46 "
HISTORIC SITES
1 BIRTHPLACES OF JOHN AND JOHN QUINCY ADAMS
2 QUINCY CITY HALL
3 HANCOCK CEMETERY
4 FIRST PARISH CHURCH
5 ABIGAIL ADAMS CAIRN
800 0 800 1600
SCALE IN FEET
1 PLANNED AUXILIARY CONDUIT (BY OTHERS)
2 PROPOSED BYPASS TUNNEL
TOWN BROOK QUINCY, MASSACHUSETTS
WATERSHED MAP
HYDROLOGIC ENGR. SECT. OCT. 1979

PLATE I

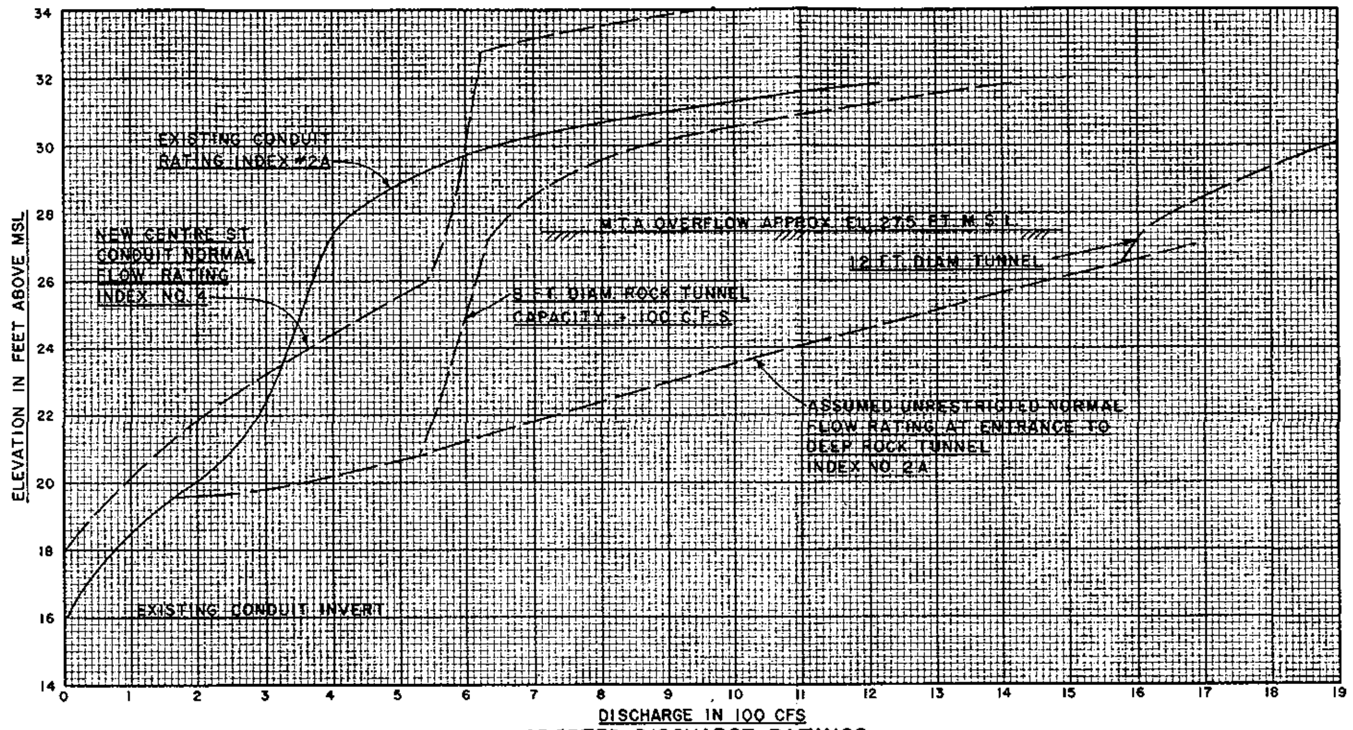
CORPS OF ENGINEERS A B C D E F G H U. S. ARMY



OLD QUINCY RESERVOIR



EXISTING CONDITIONS RATING CURVES



ADOPTED DISCHARGE RATINGS WITH IMPROVED CONDITIONS

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, DESIGN BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH

TOWN BROOK QUINCY, MASSACHUSETTS

DISCHARGE RATING CURVES

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

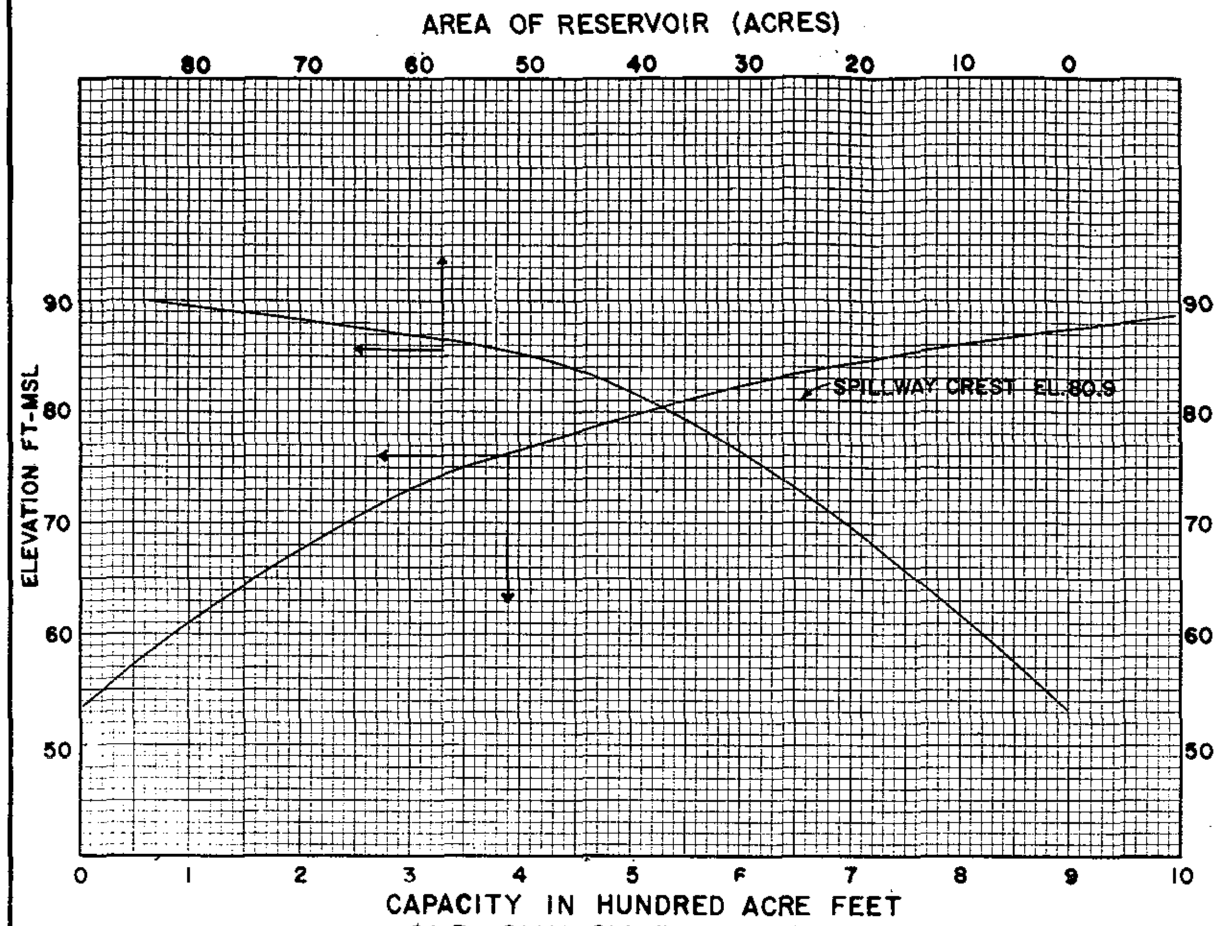
APPROVED DATE

CHIEF, ENGINEERING DIVISION

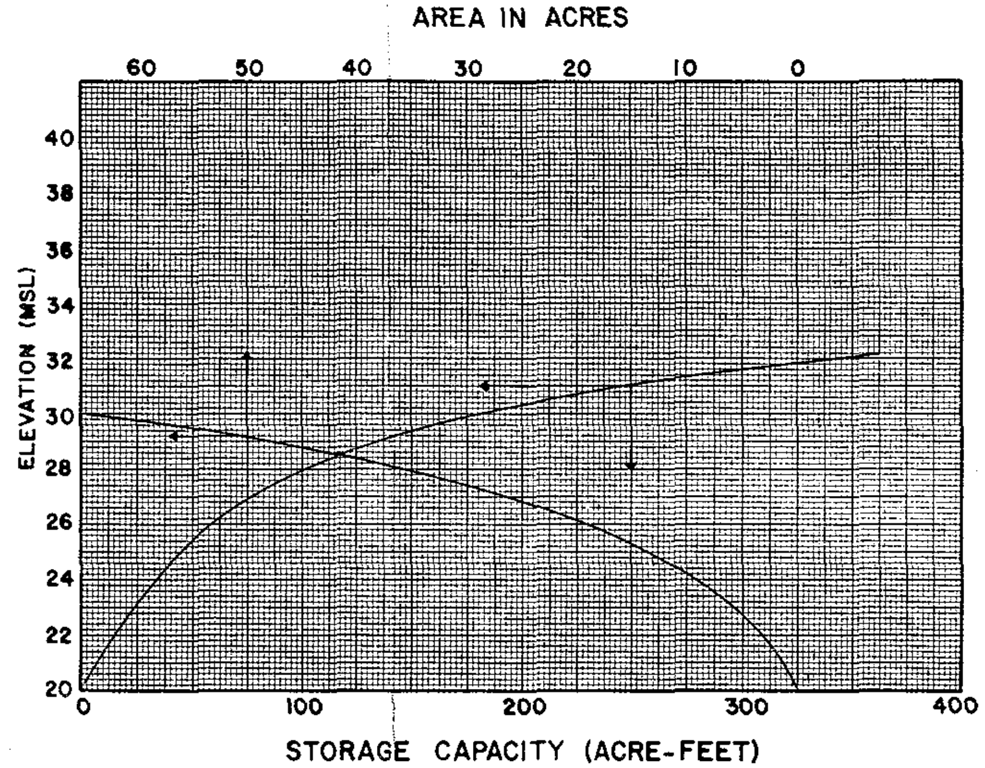
SCALE | SPEC. NO. | DRAWING NUMBER

SHEET

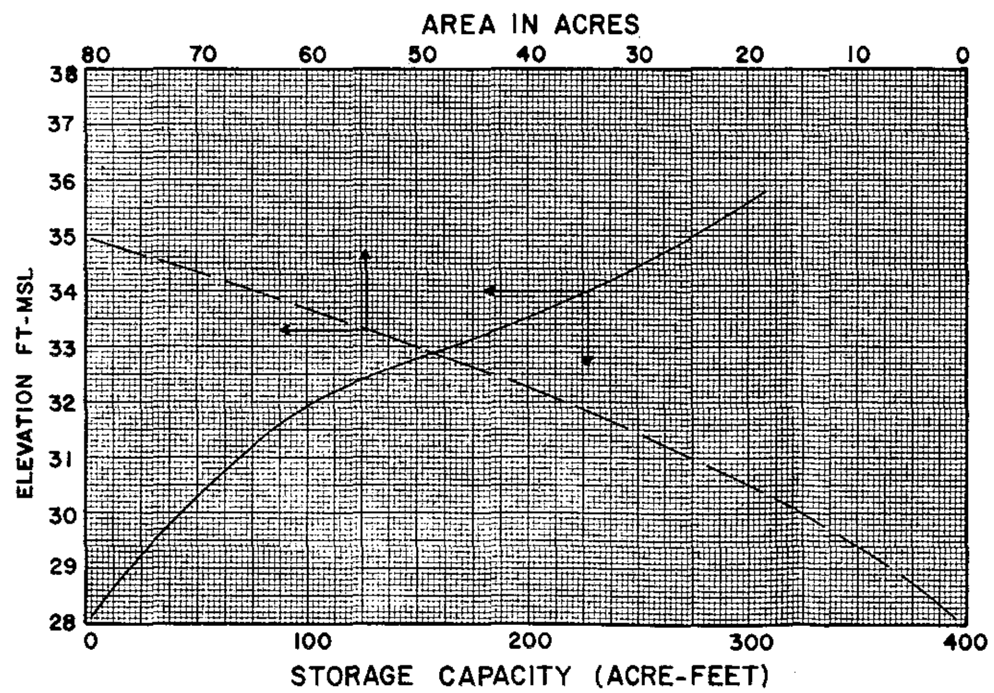
PLATE 2



OLD QUINCY RESERVOIR



BROOK ROAD POOL



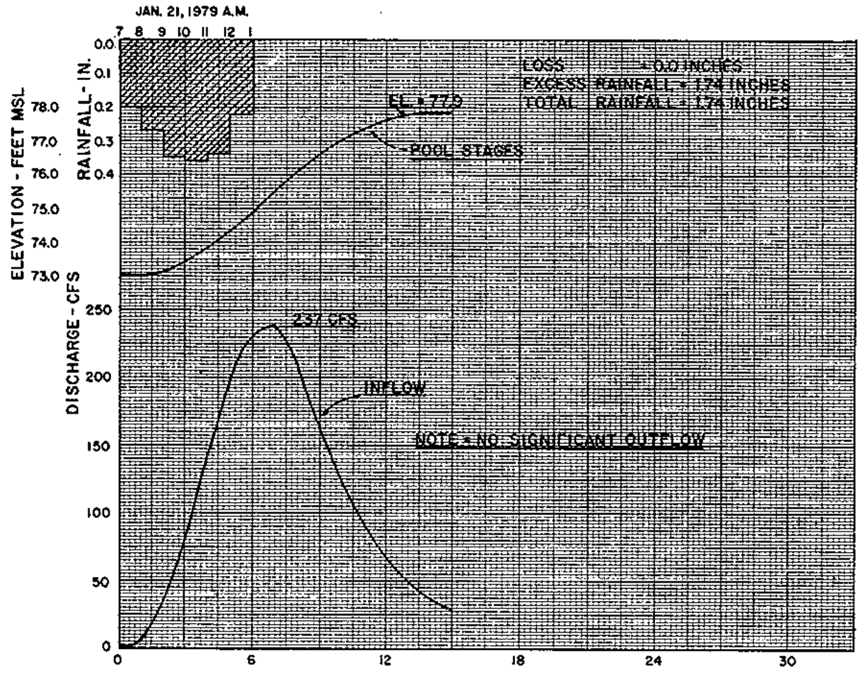
CENTRE STREET POOL

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DRAWN BY:	TOWN BROOK QUINCY, MASS.
TRACED BY:	STORAGE-CAPACITY CURVES
CHECKED BY:	
APPROVED:	HYDRO. ENGR. SECT. SEPT. 1979
	SCALE: DATE:
	SHEET OF

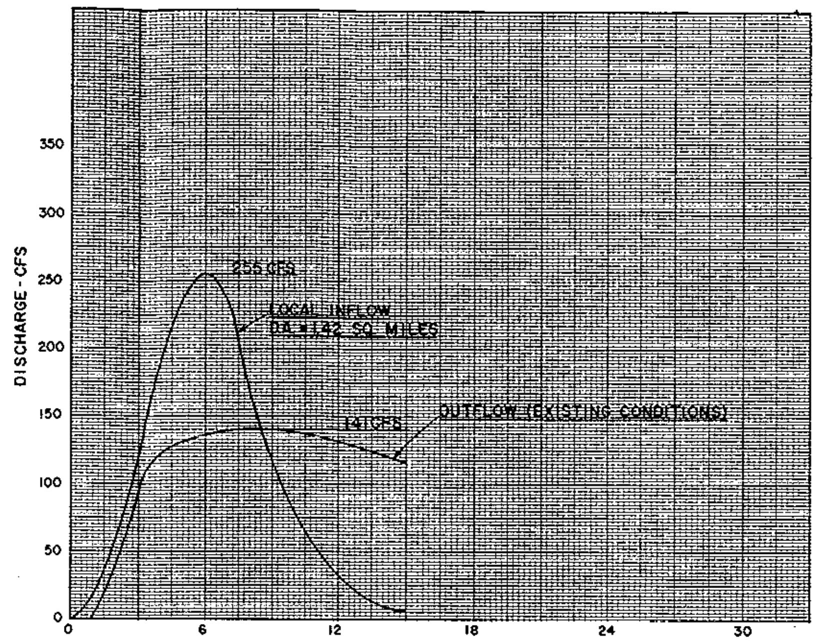
PLATE 3

CORPS OF ENGINEERS U. S. ARMY



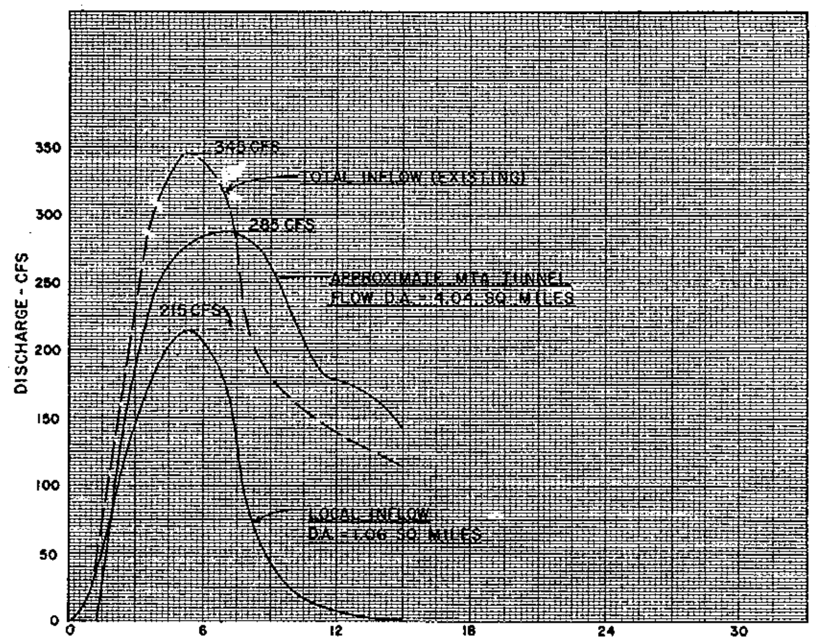
OLD QUINCY RESERVOIR

D.A. = 1.56 SQ. MILES



CENTRE STREET

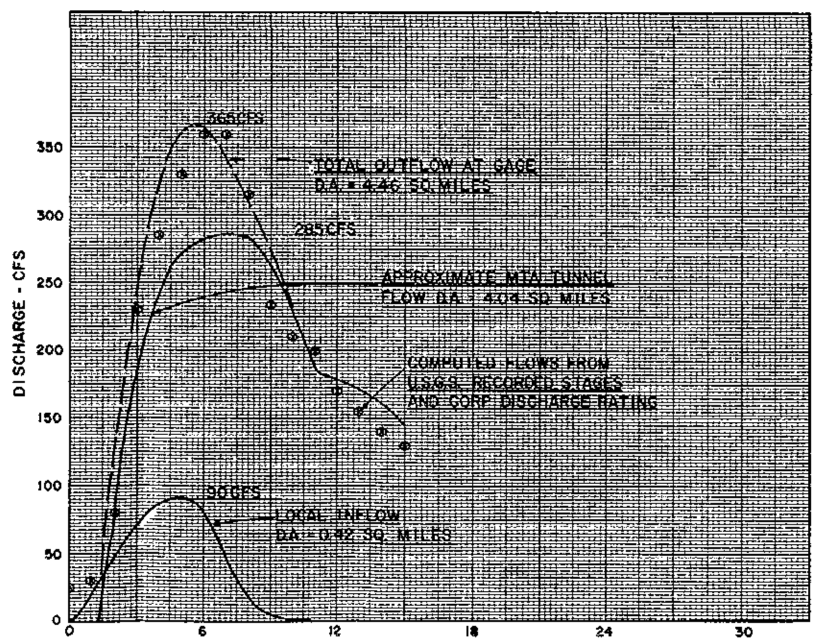
D.A. = 2.98 SQ. MILES



BROOK ROAD TO

M.T.A. TUNNEL ENTRANCE

D.A. = 4.04 SQ. MILES



U.S.G.S. GAGE NEAR

BIGELOW STREET

D.A. = 4.46 SQ. MILES

REVISION	DATE	DESCRIPTION	BY

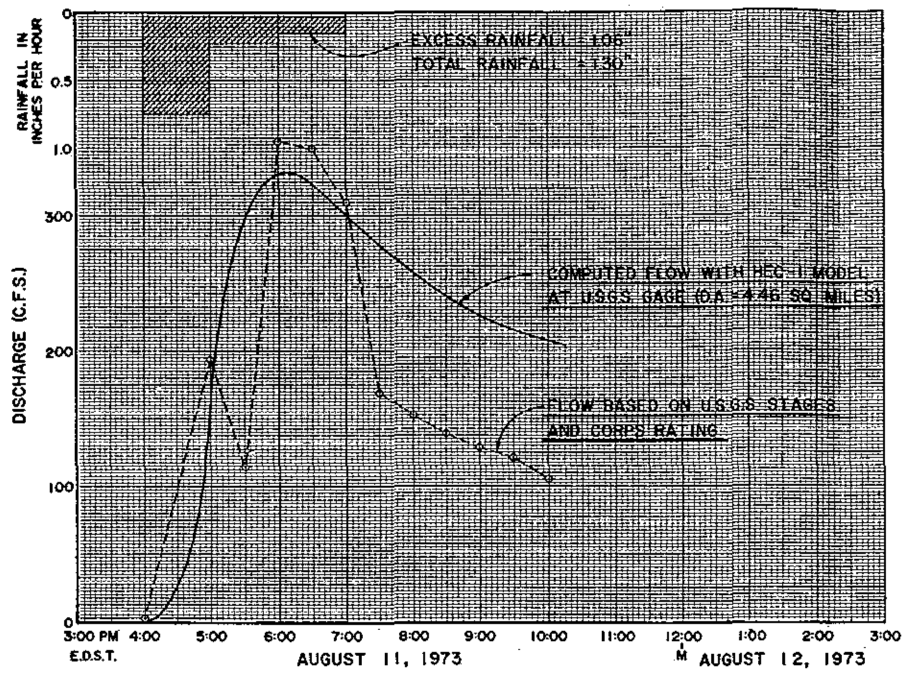
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

TOWN BROOK QUINCY, MASSACHUSETTS

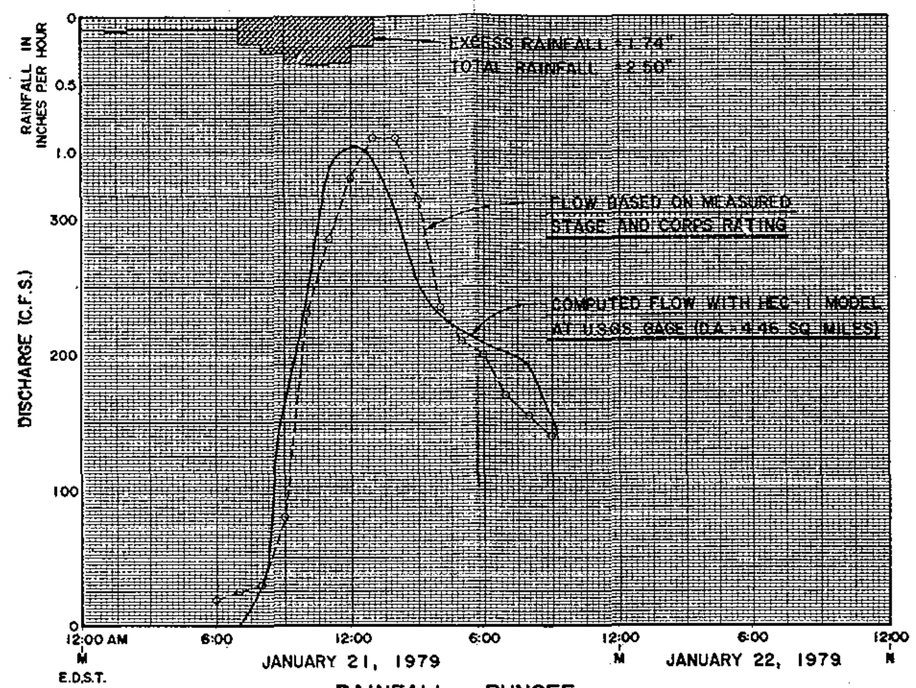
JANUARY 1979 FLOOD ANALYSIS

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

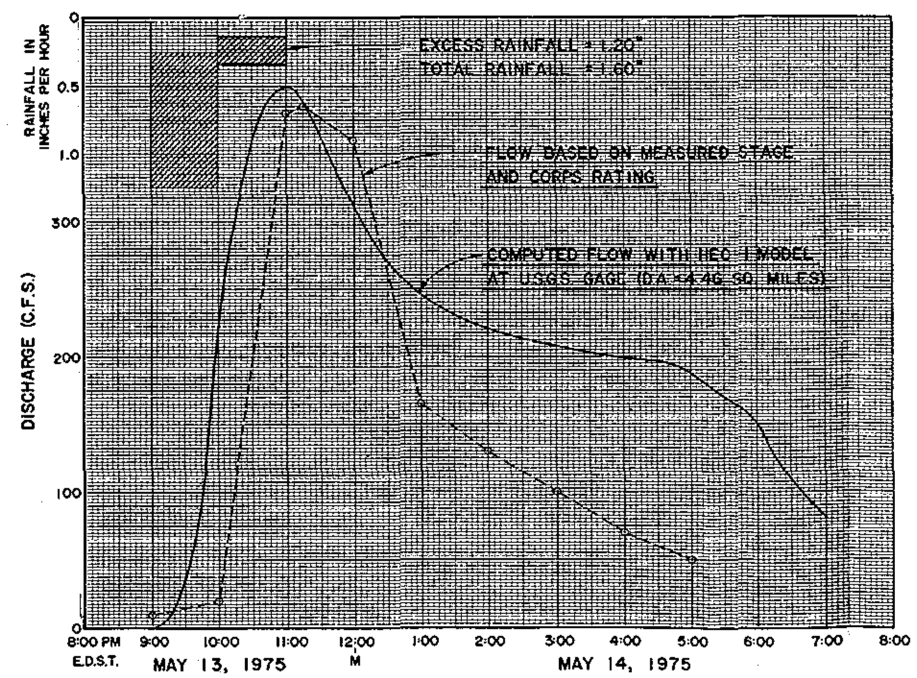
PLATE 4



RAINFALL - RUNOFF



RAINFALL - RUNOFF



RAINFALL - RUNOFF

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED: CHIEF, SECTION

APPROVAL RECOMMENDED: CHIEF, DESIGN BRANCH

REVIEWED: PROJECT ENGINEER

APPROVAL RECOMMENDED: CHIEF BRANCH

TOWN BROOK QUINCY, MASSACHUSETTS

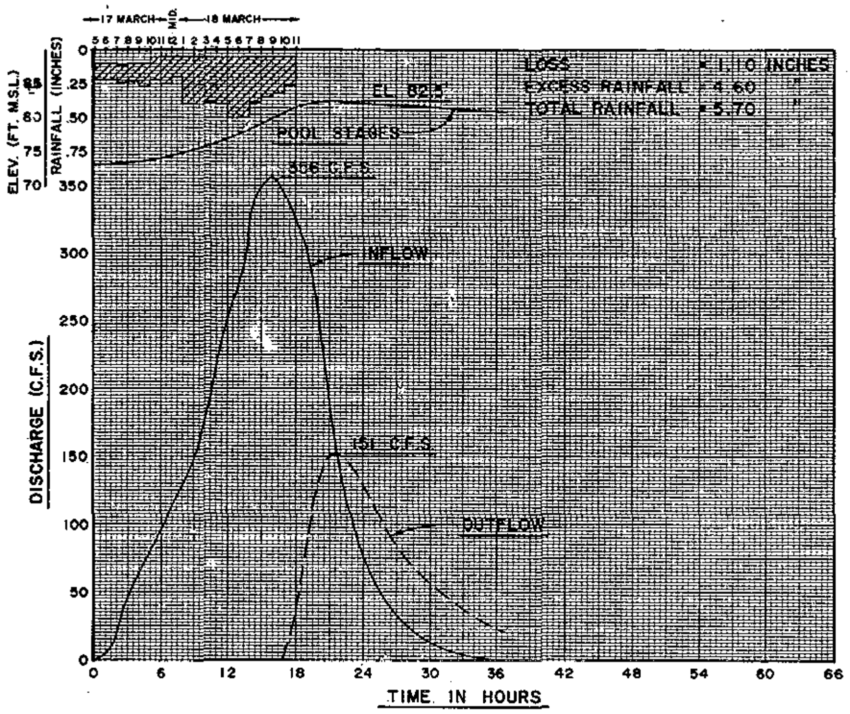
STORM RUNOFF COMPARISONS

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

APPROVED CHIEF, ENGINEERING DIVISION DATE

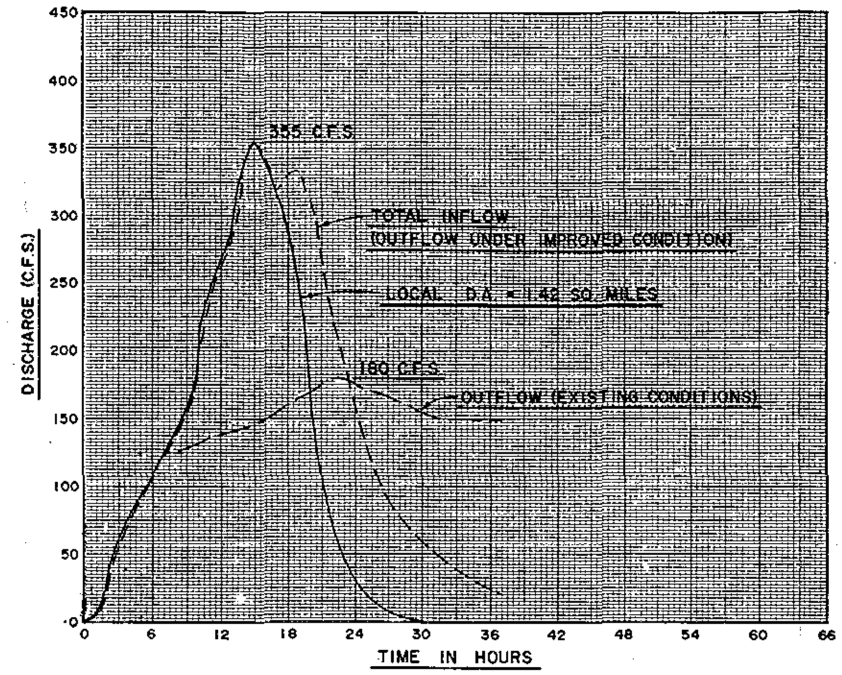
SCALE | SPEC. NO. | DRAWING NUMBER | SHEET

PLATE 5



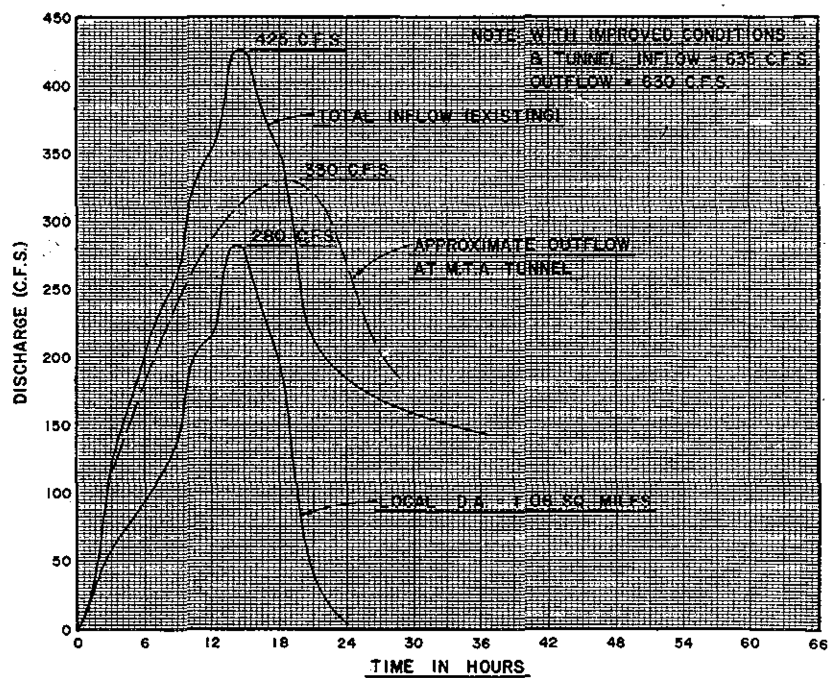
QUINCY RESERVOIR

D.A. = 1.56 SQ. MILES



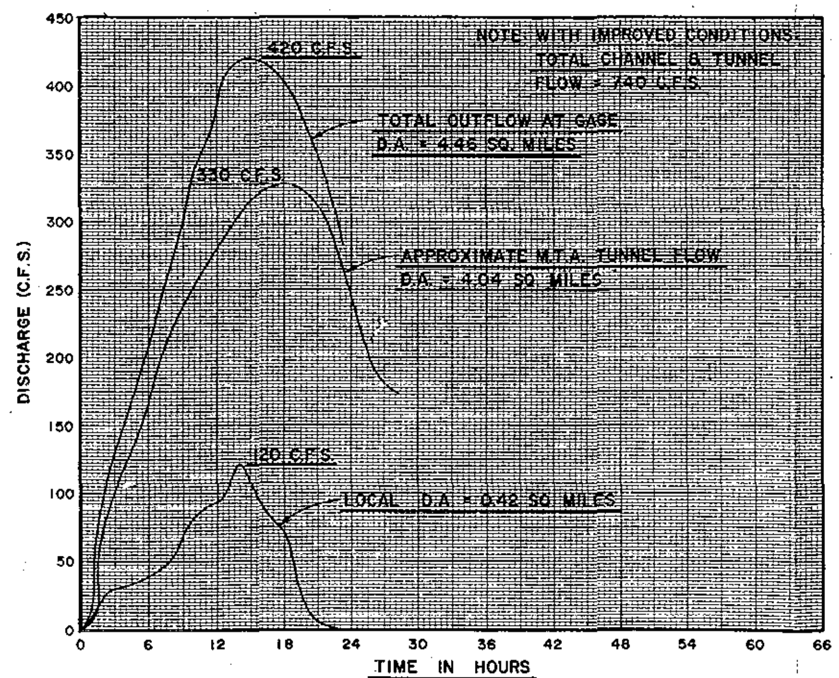
CENTRE STREET

D.A. = 2.98 SQ. MILES



BROOK ROAD TO
M.T.A. TUNNEL ENTRANCE

D.A. = 4.04 SQ. MILES



U.S.G.S. GAGE NEAR
BIGELOW STREET

D.A. = 4.46 SQ. MILES

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

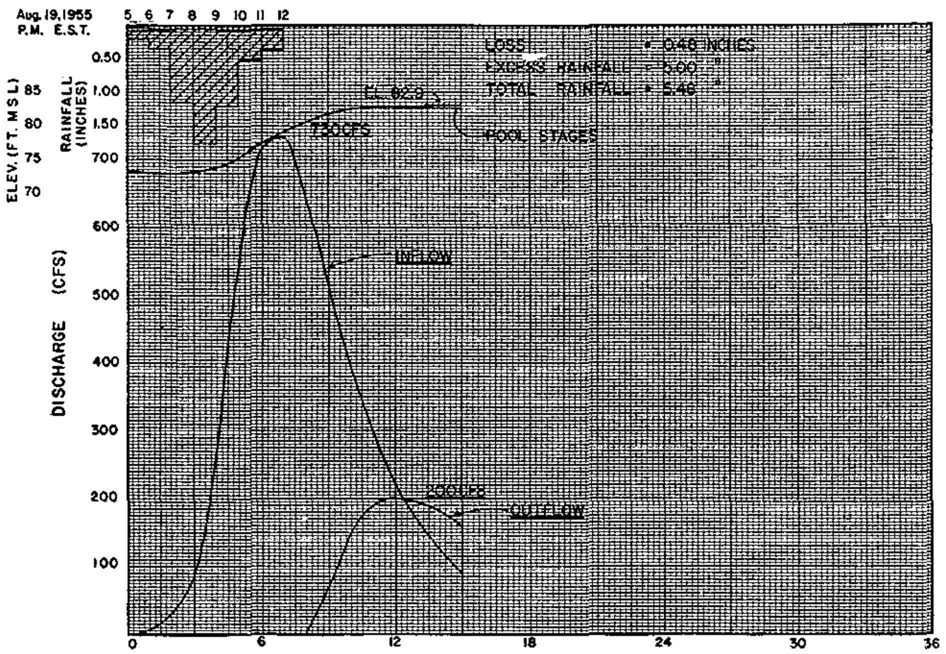
TOWN BROOK QUINCY, MASSACHUSETTS

MARCH 1968 FLOOD ANALYSIS

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

PLATE 6

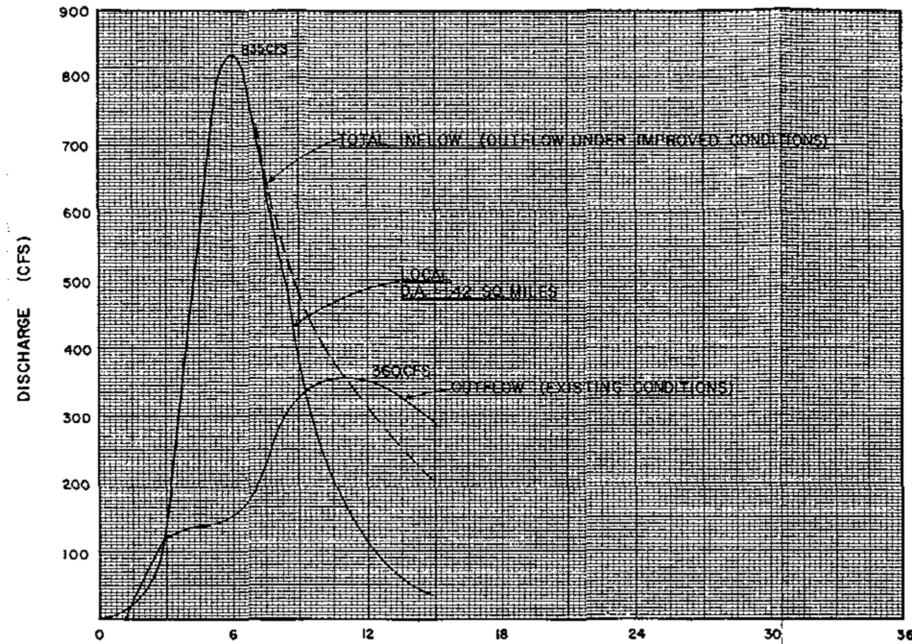
CORPS OF ENGINEERS U. S. ARMY



TIME IN HOURS

QUINCY RESERVOIR

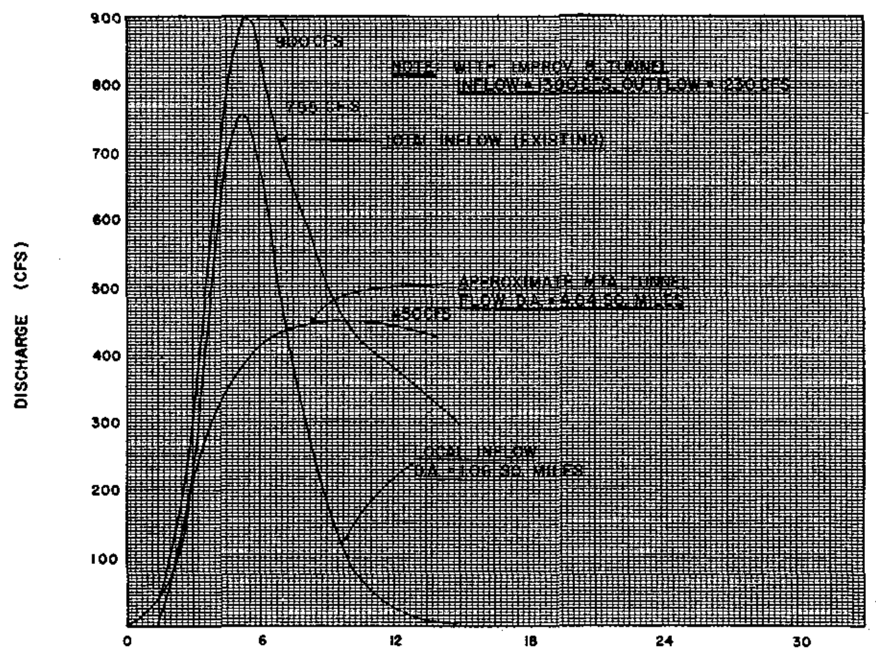
D.A. = 1.56 SQ. MILES



TIME IN HOURS

CENTRE STREET

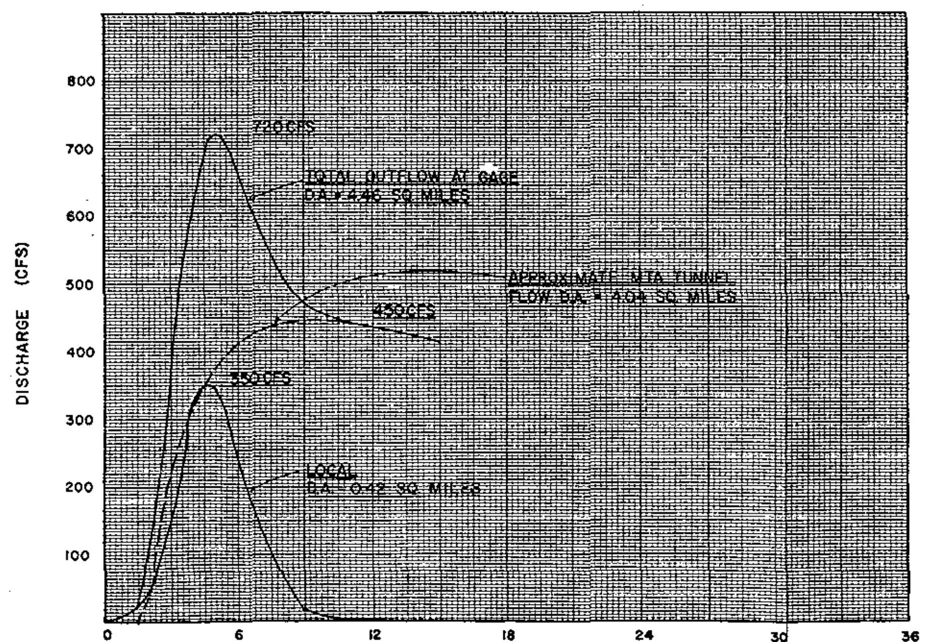
D.A. = 2.98 SQ. MILES



TIME IN HOURS

BROOK ROAD TO M.T.A. TUNNEL ENTRANCE

D.A. = 4.04 SQ. MILES



TIME IN HOURS

USGS GAGE NEAR BIGELOW STREET

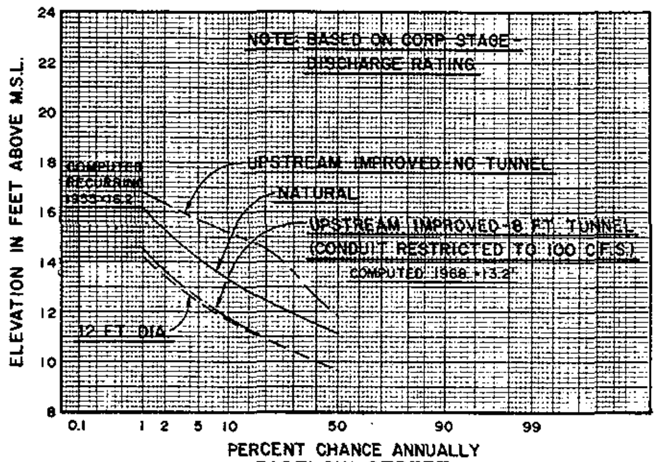
D.A. = 4.46 SQ. MILES

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

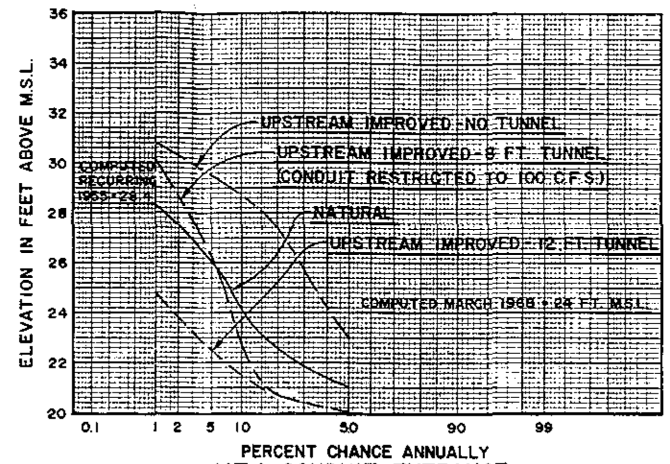
DES. BY / DR. BY / CK. BY	TOWN BROOK — QUINCY, MASSACHUSETTS
SUBMITTED: CHIEF, SECTION	**AUGUST 1955 FLOOD ANALYSIS**
APPROVAL RECOMMENDED: CHIEF, DESIGN BRANCH	
REVIEWED: PROJECT ENGINEER	HYDROLOGIC ENGINEERING SECTION — SEPT. 1979
APPROVAL RECOMMENDED: CHIEF BRANCH	APPROVED: CHIEF, ENGINEERING DIVISION — DATE
	SCALE — SPEC. NO. — DRAWING NUMBER — SHEET

PLATE 7

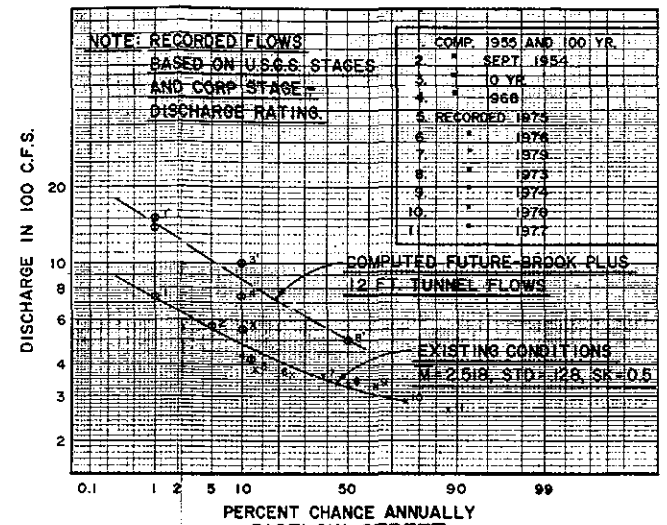
CORPS OF ENGINEERS A B C D E F G H U. S. ARMY



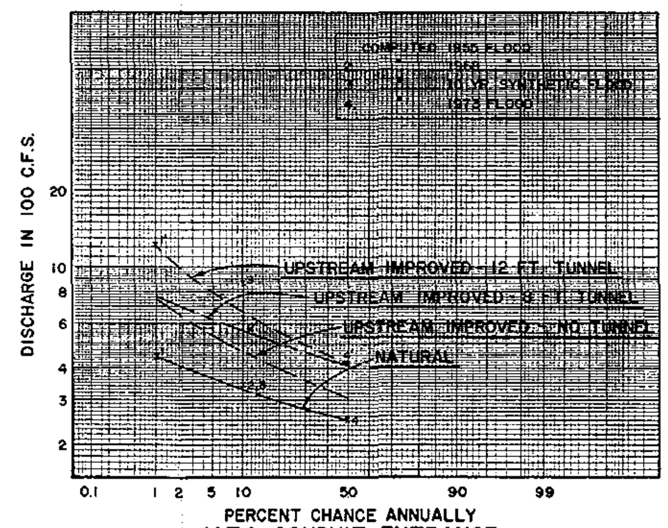
BIGELOW STREET
USGS GAGE
INDEX STA. #2
D.A. = 4.46 SQ. MILES



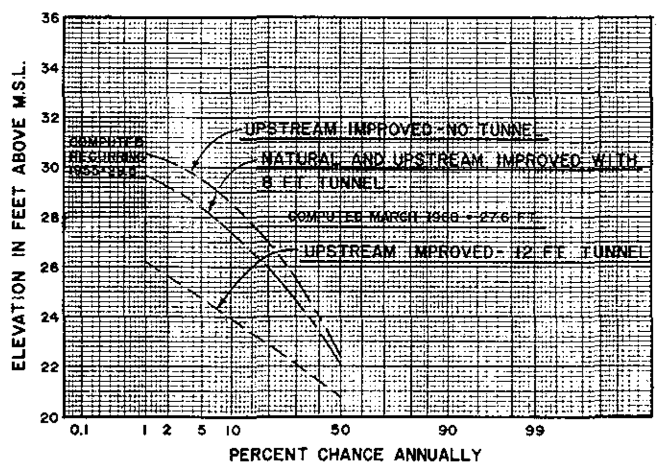
M.T.A. CONDUIT ENTRANCE
INDEX STA. #2A
D.A. = 4.04 SQ. MILES



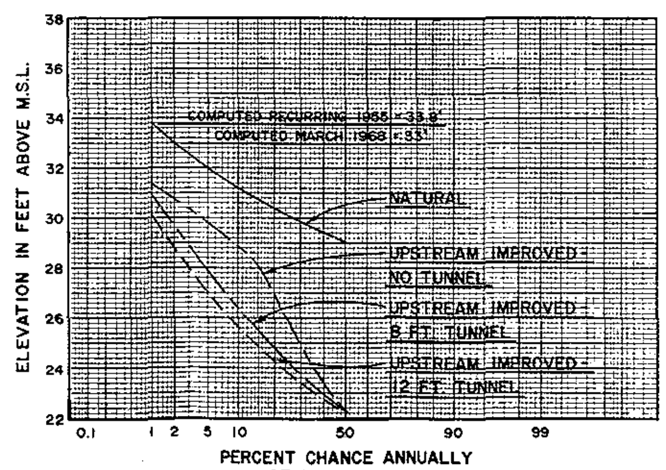
BIGELOW STREET
USGS GAGE
INDEX STA. # 2
D. A. = 4. 46 SQ. MILES



M.T.A. CONDUIT ENTRANCE
INDEX STA.# 2A
D.A. = 4.04 SQ. MILES



BROOK ROAD
INDEX STA. #3



CENTRE STREET
INDEX STA. #4
D.A. = 2.98 SQ. MILES

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

TOWN BROOK QUINCY, MASSACHUSETTS

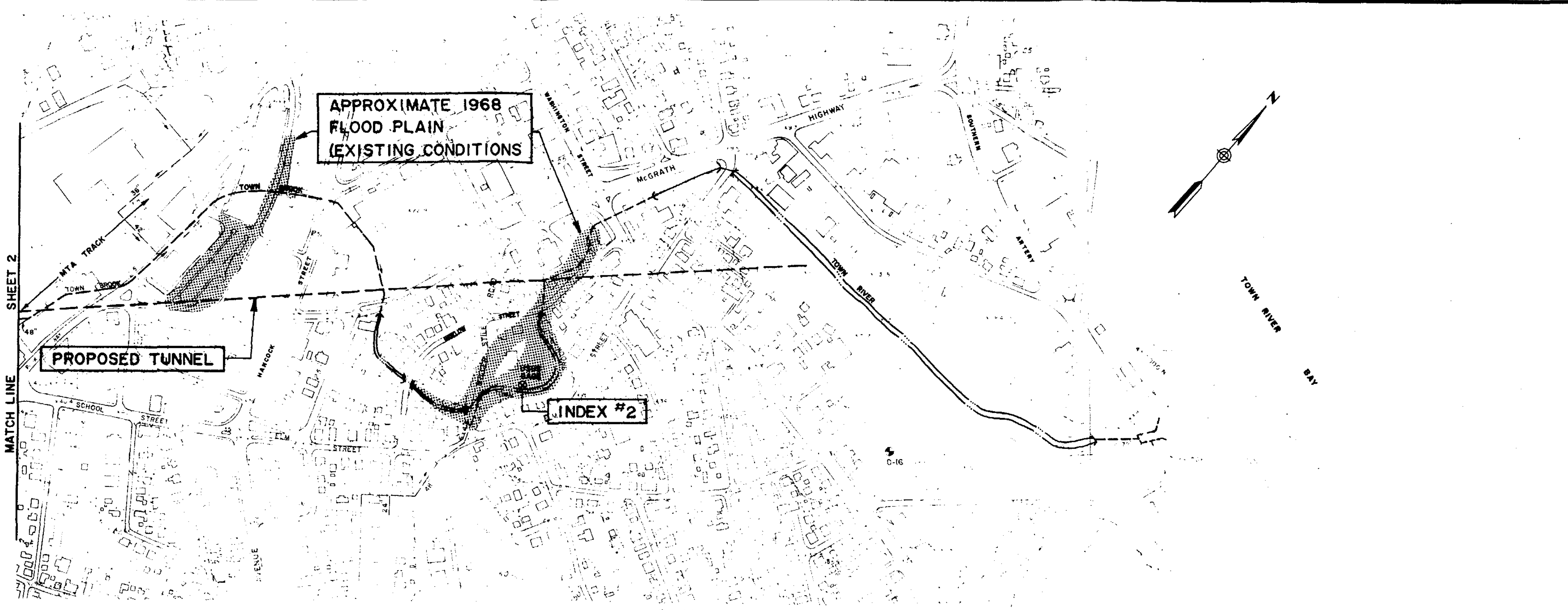
DISCHARGE & STAGE FREQUENCY CURVES

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

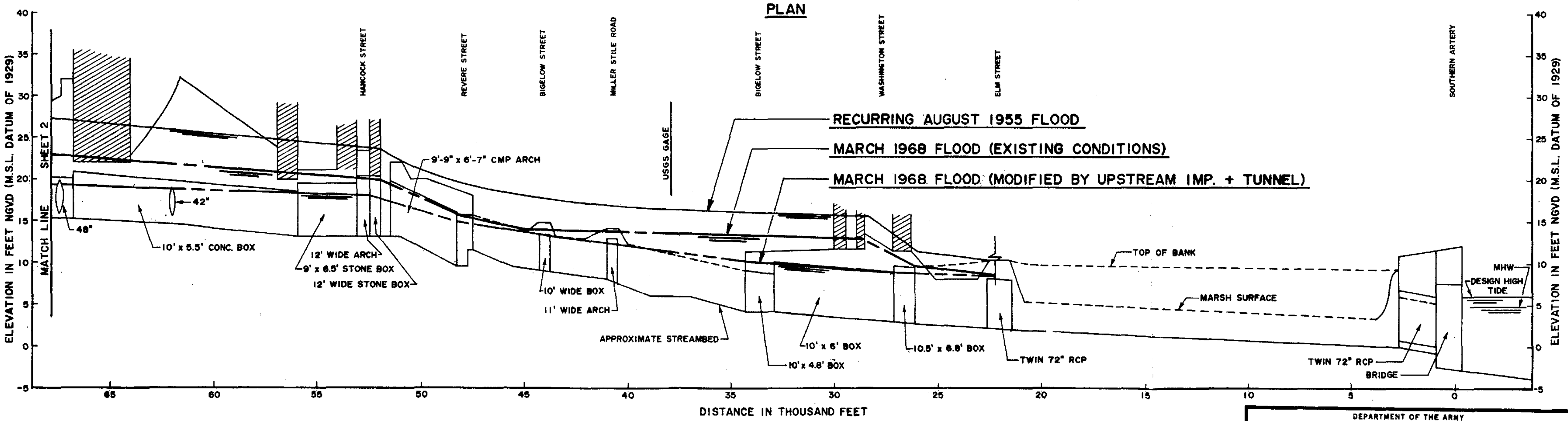
DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
APPROVAL RECOMMENDED:
CHIEF, DESIGN BRANCH
REVIEWED:
PROJECT ENGINEER
APPROVAL RECOMMENDED:
CHIEF BRANCH
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE | SPEC. NO.
DRAWING NUMBER
SHEET

PLATE 8

CORPS OF ENGINEERS U. S. ARMY



PLAN



PROFILE

GRAPHIC SCALE 200' 0 200' 400'

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

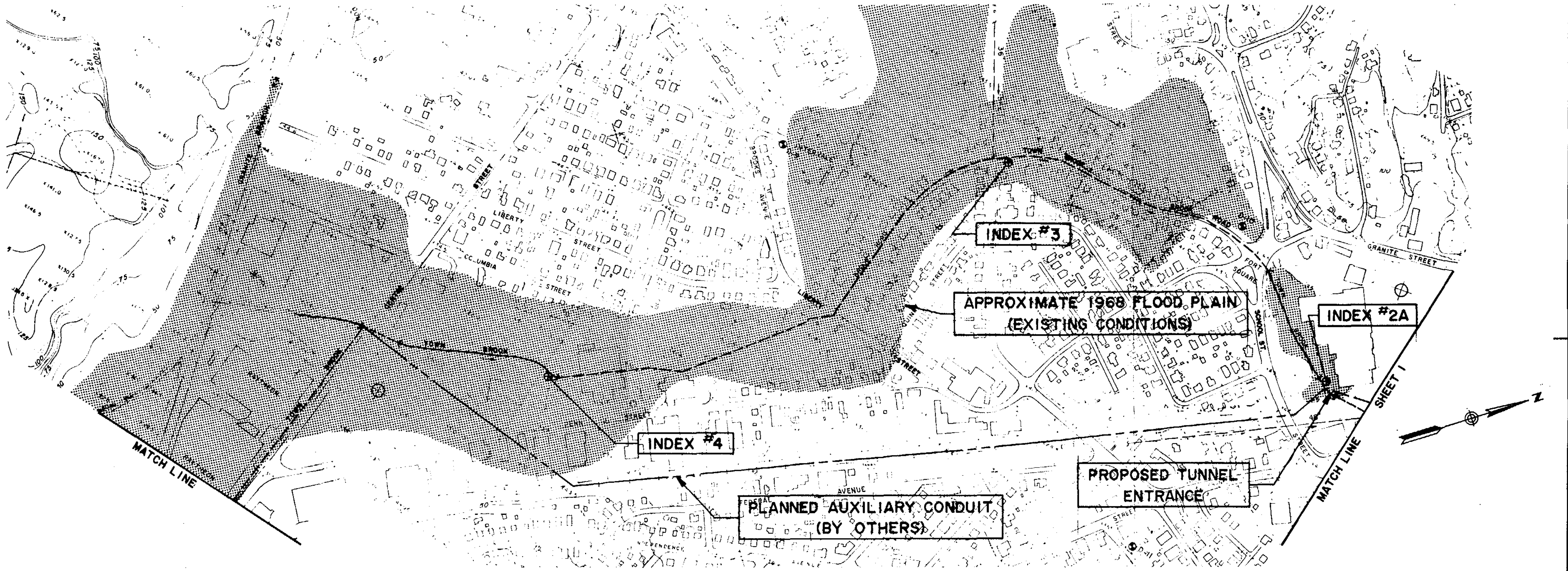
TOWN BROOK QUINCY, MASSACHUSETTS

PLAN & PROFILES #1

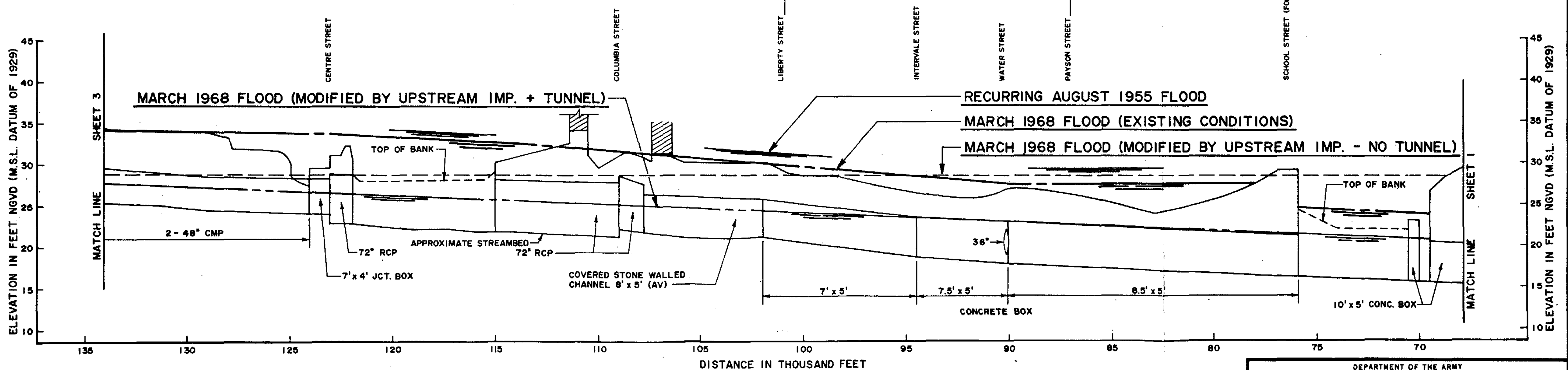
HYDROLOGIC ENGINEERING SECTION SEPT. 1979

PLATE 9

CORPS OF ENGINEERS U. S. ARMY



PLAN



PROFILE

GRAPHIC SCALE
200' 0 200' 400'

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

TOWN BROOK QUINCY, MASSACHUSETTS

PLAN & PROFILES #2

HYDROLOGIC ENGINEERING SECTION SEPT. 1979

PLATE 10